CLAIMS

1. A radio communication system comprising:

a space-division-multiplex compatible mobile station compatible with space division multiplex transmission;

a space-division-multiplex uncompatible mobile station uncompatible with space division multiplex transmission; and

a base station apparatus including

partial-space orthogonalizing means for making a weighting process, for enhancing orthogonality over a propagation path for the space division multiplex transmission, on a transmission data sequence to be sent by space division multiplex to the space-division-multiplex compatible mobile station allocated for space division multiplex transmission within a communication area,

a beam forming section for forming a transmission beam to the space-division-multiplex compatible mobile station and the space-division-multiple-access mobile station, responsive to a transmission data sequence to the space-division-multiple-access mobile station allocated for space division multiple access within a communication area and to an output of the partial-space orthogonizing means, the transmission beam being to reduce an interference with another mobile station to access simultaneously, and

a plurality of antennas for transmitting the transmission beam.

2. A radio communication system according to claim 1,

wherein, forming the transmission beam for reducing an interference by the beam forming section of the base station apparatus is to form the transmission beam from the transmission data sequence to the allocated space-division-multiple-access mobile station and an output of the partial-space orthogonalizing means in a manner being orthogonal to a channel estimation matrix on another mobile station to access simultaneously.

3. A radio communication method comprising:

a step for a base station apparatus to calculate a space division multiplex transmission evaluation criterion and space-division-multiple-access evaluation criterion, on a basis of a channel estimation matrix and received quality for a space-division-multiplex compatible mobile station and space-division-multiplex uncompatible mobile station;

a step for the base station apparatus to allocate the space-division-multiplex compatible mobile station to space division multiplex transmission by the space division multiplex transmission evaluation criterion and make a weighting process for an enhancement of orthogonality over a propagation path for the space division multiplex transmission, on a transmission data sequence to be sent by space division multiplex to the allocated space-division-multiplex compatible mobile station; and

a step for the base station apparatus to assign the space-division-multiplex compatible mobile station and

space-division-multiplex uncompatible mobile station to space division multiple access by the space-division-multiple-access evaluation criterion, and form a transmission beam to the space-division-multiplex compatible mobile station and space-division-multiple-access mobile station responsive to a transmission data sequence to the allocated space-division-multiple-access mobile station and the transmission data sequence weighting-processed and to be sent by space division multiplex, the transmission beam being to reduce an interference with another mobile station to access simultaneously, thus sending same from the base-station antenna.

4. A radio communication method according to claim 3, further comprising

a step for the base station apparatus to send known signals on each of antennas provided in a number of N,

a step for the space-division-multiplex compatible mobile station and space-division-multiplex uncompatible mobile station to measure, on each of antennas provided in a total number of M, a channel estimation matrix constituted by channel estimation values in a number of $N \times M$ by use of a received result of the known signals in a number of N, and further to measure a received quality, and

a step for the space-division-multiplex compatible mobile station and space-division-multiplex uncompatible mobile station to send the channel estimation matrix and received

quality to the base-station apparatus through a communication line,

wherein, forming the transmission beam for reducing an interference by the base station apparatus is to form the transmission beam from a transmission data sequence to the space-division-multiple-access mobile station allocated and a transmission data sequence weight-processed and to be sent by space division multiplex, in a manner being orthogonal to a channel estimation matrix on another mobile station to access simultaneously.

5. A radio communication method according to claim 3, wherein the known signal is to be sent by time division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

6. A radio communication method according to claim 4, wherein the known signal is to be sent by time division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

7. A radio communication method according to claim 3, wherein the known signal is to be sent by code division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

8. A radio communication method according to claim 4, wherein the known signal is to be sent by code division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

9. A radio communication method according to claim 3, wherein the known signal is to be sent by a combination of time division multiplex and code division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

10. A radio communication method according to claim 4, wherein the known signal is to be sent by a combination of time division multiplex and code division multiplex on an antenna-by-antenna basis by use of different code sequences from base-station antennas in the number of N.

11. A radio communication method comprising:

a step for a space-division-multiplex compatible mobile station and space-division-multiplex uncompatible mobile station to send known signals to the base-station apparatus at each of antennas provided thereon in a total number of M;

a step for a base station apparatus to receive at each of a plurality N of base-station antennas and measure a channel estimation matrix constituted by channel estimation values in a number of N × M depending upon the known signal, and further to measure a received quality;

a step for the base station apparatus to calculate a space division multiplex transmission estimating criterion and space-division-multiple-access estimating criterion depending upon the channel estimation matrix and the received quality;

a step for the base station apparatus to allocate the

space-division-multiplex compatible mobile station to space division multiplex transmission by the space division multiplex transmission evaluation criterion and make a weighting process for an enhancement of orthogonality, over a propagation path for the space division multiplex transmission, on a transmission data sequence to be sent by space division multiplex to the allocated space-division-multiplex compatible mobile station; and

a step for the base station apparatus to allocate the space-division-multiplex compatible mobile station and space-division-multiplex uncompatible mobile station to space division multiple access by the space-division-multiple-access evaluation criterion, and form a transmission beam to the space-division-multiplex compatible mobile station and space-division-multiple-access mobile station responsive to a transmission data sequence to the allocated space-division-multiple-access mobile station and the transmission data sequence weighting-processed and to be sent by space division multiplex, the transmission beam being to reduce an interference with another mobile station to access simultaneously, thus transmitting the transmission beam from the base-station antenna.

12. A radio communication method according to claim 11, wherein, forming the transmission beam for reducing an interference by the base station is to form the transmission beam from a transmission data sequence to the allocated

space-division-multiple-access mobile station and a transmission data sequence weight-processed and to be sent by space division multiplex, in a manner being orthogonal to a channel estimation matrix on another mobile station to access simultaneously.

13. A radio communication method according to claim 3, wherein the received quality uses any of received-signal-power-to-noise-power ratio, received-signal-power-to-interference-power ratio and received power.

14. A radio communication method according to claim 11, wherein the received quality uses any of received-signal-power-to-noise-power ratio, received-signal-power-to-interference-power ratio and received power.

15. A radio communication method according to claim 3, wherein the received quality uses received-signal-power-to-noise-power ratio, and any one of mobile station moving speed and fading frequency estimation value.

16. A radio communication method according to claim 11, wherein the received quality uses received-signal-power-to-noise-power ratio, and any one of mobile station moving speed and fading frequency estimation value.

17. A radio communication method according to claim 3,

wherein the step of calculating a space division multiplex transmission estimating criterion comprises

a step of selecting a space-division-multiplex compatible mobile station satisfying a predetermined received quality, and

a step of deciding a space division multiplex transmission count depending upon a space correlation coefficient of between channel estimation values in a number of N obtained between different antennas on the space-division-multiplex compatible mobile station of among selected ones of the space-division-multiplex compatible mobile stations.

18. A radio communication method according to claim 11, wherein the step of calculating a space division multiplex transmission estimating criterion comprises

a step of selecting a space-division-multiplex compatible mobile station satisfying a predetermined received quality, and

a step of deciding a space division multiplex transmission count depending upon a space correlation coefficient of between channel estimation values in a number of N obtained between different antennas on the space-division-multiplex compatible mobile station of among selected ones of the space-division-multiplex compatible mobile stations.

19. A radio communication method according to claim 3, wherein the base station apparatus embeds previously a known signal in a data sequence to be sent on a transmission beam

to the space-division-multiplex compatible mobile station or the space-division-multiplex uncompatible mobile station that is space-division-multiple accessed,

and the space-division-multiplex compatible mobile station space-division-multiple accessed calculates a channel estimation value depending upon the known signal and makes demultiplex-receiving of a signal sent by space division multiplex depending upon the channel estimation value.

20. A radio communication method according to claim 4, wherein the base station apparatus embeds previously a known signal in a data sequence to be sent on a transmission beam to the space-division-multiplex compatible mobile station or the space-division-multiplex uncompatible mobile station that is space-division-multiple accessed,

and the space-division-multiplex compatible mobile station space-division-multiple accessed calculates a channel estimation value depending upon the known signal and makes demultiplex-receiving of a signal sent by space division multiplex depending upon the channel estimation value.

21. A radio communication method according to claim 3, wherein the step of calculating a space-division-multiple-access evaluation criterion comprises

a step of allocating the mobile station, with priority, by predetermined scheduling means,

a step of selecting a space-division-multiplex

compatible mobile station or space-division-multiplex uncompatible mobile station satisfying a predetermined received quality from the others than the mobile station allocated with priority, and

a step of selecting a mobile station having an antenna minimal in a space correlation coefficient to a channel estimation matrix obtained at an antenna of the mobile station allocated with priority from among selected ones of the space-division-multiplex compatible mobile stations or space-division-multiplex uncompatible mobile stations.

22. A radio communication method according to claim 11, wherein the step of calculating a space-division-multiple-access evaluation criterion comprises

a step of allocating the mobile station, with priority, by predetermined scheduling means,

a step of selecting a space-division-multiplex compatible mobile station or space-division-multiplex uncompatible mobile station satisfying a predetermined received quality from the others than the mobile station allocated with priority, and

a step of selecting a mobile station having an antenna minimal in a space correlation coefficient to a channel estimation matrix obtained at an antenna of the mobile station allocated with priority from among selected ones of the space-division-multiplex compatible mobile stations or

space-division-multiplex uncompatible mobile stations.

23. A radio communication method according to claim 3, wherein the transmission beam for space division multiple access or space division multiplex transmission is placed under power control into a predetermined communication quality.

24. A radio communication method according to claim 11, wherein the transmission beam for space division multiple access or space division multiplex transmission is placed under power control into a predetermined communication quality.

25. A radio communication method according to claim 23, wherein power control is made to set a communication quality of from the base station apparatus to the space-division-multiplex uncompatible mobile station higher than a communication quality of from the base station apparatus to the space-division-multiplex compatible mobile station.

26. A radio communication method according to claim 24, wherein power control is made to set a communication quality of from the base station apparatus to the space-division-multiplex uncompatible mobile station higher than a communication quality of from the base station apparatus to the space-division-multiplex compatible mobile station.

27. A radio communication method according to claim 3, wherein the space-division-multiple-access evaluation criterion is to give priority to a multiple access of between the space-division-multiplex uncompatible mobile stations in the case that call loss is greater than a predetermined value.

28. A radio communication method according to claim 11, wherein the space-division-multiple-access evaluation criterion is to give priority to a multiple access of between the space-division-multiplex uncompatible mobile stations in the case that call loss is greater than a predetermined value.

29. A base station apparatus comprising:

a partial-space orthogonalizing means for making a weighting process, for enhancing orthogonality over a propagation path for the space division multiplex transmission, on a transmission data sequence to be sent by space division multiplex to the space-division-multiplex compatible mobile station allocated for space division multiplex transmission within a communication area;

a beam forming section for forming a transmission beam to the mobile station responsive to a transmission data sequence to the space-division-multiple-access mobile station allocated for space division multiple access within a communication area and an output of the partial-space orthogonizing means, the transmission beam to the mobile station being to reduce an interference with another mobile station to access simultaneously; and

a plurality of antennas for transmitting the transmission beam.

30. A base station apparatus according to claim 29, wherein forming the transmission beam for reducing an interference by the beam forming section is to form the transmission beam from

the transmission data sequence to the allocated space-division-multiple-access mobile station and the output of the partial-space orthogonizing means, in a manner being orthogonal to a channel estimation matrix on another mobile station to access simultaneously.

31. A base station apparatus according to claim 29, wherein, in a case that the space-division-multiplex compatible mobile station and the space-division-multiplex uncompatible mobile station are allocated for space division multiple access at a same time, the beam forming section makes, for the space-division-multiplex uncompatible mobile station, a maximum ratio synthetic beam as a transmission beam to the space-division-multiplex uncompatible mobile station and, for the space-division-multiplex compatible mobile station, a transmission beam as a beam for reducing an interference with another of the space-division-multiplex uncompatible mobile station and space-division-multiplex compatible mobile station to access simultaneously.

32. A base station apparatus according to claim 30, wherein, in a case that the space-division-multiplex compatible mobile station and the space-division-multiplex uncompatible mobile station are allocated for space division multiple access at a same time, the beam forming section makes, for the space-division-multiplex uncompatible mobile station, a maximum ratio synthetic beam as a transmission beam to the space-division-multiplex uncompatible mobile station and, for

the space-division-multiplex compatible mobile station, a transmission beam as a beam for reducing an interference with another of the space-division-multiplex uncompatible mobile station and space-division-multiplex compatible mobile station to access simultaneously.

33. A base station apparatus according to claim 29, wherein, forming the transmission beam for reducing an interference by the beam forming section is to form the transmission beam orthogonal to a channel estimation matrix on another of the space-division-multiplex uncompatible mobile station and space-division-multiplex compatible mobile station to access simultaneously.

34. A base station apparatus according to claim 29, further comprising space-time coding means for making a space-time coding process on a transmission data sequence to the space-division-multiplex compatible mobile station,

the transmission data sequence space-time -coded being outputted to the partial-space orthogonizing means.

35. A base station apparatus according to claim 30, further comprising space-timecoding means for making a space-time coding process on a transmission data sequence to the space-division-multiplex compatible mobile station,

the transmission data sequence space-time -coded being outputted to the partial-space orthogonizing means.

36. A base station apparatus according to claim 29, further comprising a deciding section for allocating the

space-division-multiple-access mobile station and the space-division-multiplex mobile station by use of a predetermined space division multiplex transmission evaluation criterion and space-division-multiple-access evaluation criterion.

37. A base station apparatus according to claim 30, further comprising a deciding section for allocating the space-division-multiple-access mobile station and the space-division-multiplex mobile station by use of a predetermined space-division-multiplex transmission evaluation criterion and space-division-multiple-access evaluation criterion.

38. A base station apparatus according to claim 33, further comprising a deciding section for allocating the space-division-multiple-access mobile station and the space-division-multiplex mobile station by use of a predetermined space-division-multiplex transmission evaluation criterion and space-division-multiple-access evaluation criterion.

39. A base station apparatus according to claim 36, wherein the space division multiplex transmission evaluation criterion and the space-division-multiple-access evaluation criterion are to be calculated depending upon a channel estimation value and received quality received from the mobile station of within the communication area.

40. A base station apparatus according to claim 37, wherein

the space division multiplex transmission evaluation criterion and the space-division-multiple-access evaluation criterion are to be calculated depending upon a channel estimation value and received quality received from the mobile station of within the communication area.

41. A base station apparatus according to claim 38, wherein the space division multiplex transmission evaluation criterion and the space-division-multiple-access evaluation criterion are to be calculated depending upon a channel estimation value and received quality received from the mobile station of within the communication area.

42. A base station apparatus according to claim 29, wherein, in a case that the space-division-multiple-access mobile stations include a space-division-multiplex compatible mobile station and a space-division-multiplex uncompatible mobile station, a transmission beam to the space-division-multiplex uncompatible mobile station is formed by use of a complex-conjugate-transposition of a channel estimation matrix on the space-division-multiplex uncompatible mobile station, and a transmission beam to the space-division-multiplex compatible mobile station is formed in a manner being orthogonal to a channel estimation matrix on another space-division-multiple-access mobile stations to access simultaneously.

43. A base station apparatus according to claim 30, wherein, in a case that the space-division-multiple-access mobile

stations include a space-division-multiplex compatible mobile station and a space-division-multiplex uncompatible mobile station, a transmission beam to the space-division-multiplex uncompatible mobile station is formed by use of a complex-conjugate-transposition of a channel estimation matrix on the space-division-multiplex uncompatible mobile station, and a transmission beam to the space-division-multiplex compatible mobile station is formed in a manner being orthogonal to a channel estimation matrix on another space-division-multiple-access mobile stations to access simultaneously.